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POWER ENGINEERS

MEMORANDUM

DATE: August 18, 2010

TO: [redacted] PE PMP (OIEE)

C: [redacted]

FROM: [redacted]
Project Engineer

SUBJECT: Conductor for Pul-e-khumri Transmission Line

MESSAGE

A question has arisen concerning the use of "high temperature, shaped conductors" for the 150 MW upgrade of the Pul-e-Khumri to Chimtala transmission line.

The answer to the question of "can these conductors be used", is yes – if the current structures can accommodate them and if the current electrical grid can accept and addition of 150 MW of power flow.

The conductors currently in use are and likely made up of multiple strands of aluminum and steel. The high temperature conductors will be made up of a different material and with each strand compressed into a trapezoidal shape. The characteristics of the high temperature conductor with differ from that of the current in-service conductor – differ in allowable tension, sag characteristics, etc. In order to assess the feasibility of the increasing the 150 MW of power flow, a study of the existing transmission line is needed. The elements of the study that must be performed for this project are the following:

1) Determine the existing conductor characteristics (present sag and tension)

2) Determine the existing tower structural details (materials, spacing, strength)

3) Model the subject line (using existing conductor spacing and characteristics) with the current Afghanistan electrical grid for power flow and stability

4) From model determine the proper size for the Pul-e-Khumri to Chimtala transmission line conductor and if additional mitigation is required to maintain the Afghanistan electrical grid when increasing power flow from 300 MW to 450 MW.

5) Accomplish the design based on the results of the modeling task – this will include the selection of the proper high temperature conductors in either a single or bundled configuration.

Discussion --

The thermal capacity of the conductor alone is usually not a sufficient answer to allow increased load capacity for a transmission line. To increase "load-flow" in a transmission line it is necessary to look at both the overall impedance characteristics of the line and the system stability characteristics. The inductance of the line has far greater impact than the line resistance (related to line size). Changing the inductance, and thus the impedance of the line will affect the system stability that will need to be studied. Changing from the present conductor to a high-temperature conductor will change the impedance cha4racteristic of the entire Pul-e-Khumri to Chimtala line. In short, changing to a high temperature conductor may not be the entire solution.

The capability of the present towers to handle the larger conductor(s) is a significant question. Structural competence is of paramount importance, not only when considering normal use, but also during extreme conditions – wind and ice loading. It is also imperative that "power flow" be considered. Questions that must be answered before moving forward include:

- Will a re-conductored line be capable of transporting the power to required destinations during various operating conditions without detrimentally impacting or collapsing the present interconnected power system?
- Will the transport of an additional 150 MW require additional system mitigation – such as synchronous condensers, capacitors, etc?

The line in question is only a few years old and was designed by PowerGrid of India. At the inception of this project, it was stated in the contact that PowerGrid of India's design would be used as a basis for the questions surrounding the upgrading of transmission line. To date, no party has been able to obtain a copy of the design documents or the design criteria. This apparently includes requests to the present owner of the line, MEW in Kabul.

As a suggested back-up, POWER has suggested to the COP, that a short ground survey be taken. This would be for distance between deadend structures just north of the Chimtala substation. The purpose of the survey would be to determine the present attachment levels on the structures and the present conductor sag – all information unknown today. Given that information it would be possible to ascertain a portion of the "design criteria" used for the present line. Still missing would be structure fabrication details. Assumptions would still have to be made about the strength of structures. The survey information is not information that can be determined from photographs and will require field work.

With the "design criteria" defined it would then be possible to perform the system power/load flow studies to determine if the present electrical system can operate successfully when transporting an additional 150 MW. Concurrently, the design details can continue to be sought from PowerGrid of India, MEW or others. The others could include the constructor or the actual fabricator of the towers.

With power flow information (along with any required mitigation), design criteria, and structure fabrication drawings or design details in hand the design for re-construction can occur. A design without these parameters determined is not a design that should be constructed without endangering the integrity of the subject line and subjecting the overall electrical system to extreme outage conditions.

Hopefully this discussion illustrates that the question regarding the use of high-temperature conductors, while important, is not the only issue surrounding the re-design of the Pul-e-Khumri to Chimtala line. The overall issue – can the Pul-e-Khumri to Chimtala line be re-designed to accommodate as much as 450 MW – must come from answers to questions regarding actual existing transmission parameters